Abundance of the Sockeye Salmon Escapement in the Alsek River Drainage, 2004

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ABUNDANCE OF THE SOCKEYE SALMON ESCAPEMENT IN THE ALSEK RIVER DRAINAGE, 2004

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TABLE OF CONTENTS

LIST OF TABLES ..... **IV**

LIST OF FIGURES ..... **IV**

ABSTRACT ..... **V**

INTRODUCTION **1**

STUDY AREA **3**

METHODS **4**

DRY BAY TAGGING 4
SPAWNING GROUND/FISHERY SAMPLING 4
ABUNDANCE 5
AGE, SEX, AND LENGTH COMPOSITION 6
OF ESCAPEMENT 6
MIGRATORY RATES/TIMING 6

RESULTS **7**

DRY BAY TAGGING 7
SPAWNING GROUND/FISHERY SAMPLING 9
ABUNDANCE 10
AGE, SEX, AND LENGTH COMPOSITION 11
OF ESCAPEMENT 11
MIGRATORY RATES/TIMING 14

DISCUSSION **15**

RECOMMENDATIONS **16**

ACKNOWLEDGEMENTS **16**

LITERATURE CITED **17**

APPENDICES **18**

LIST OF TABLES

TABLE 1. ALSEK RIVER SOCKEYE SALMON CATCH AND KLUKSHU RIVER SPAWNING ESCAPEMENTS.....1
TABLE 2. SUMMARY OF SOCKEYE CAUGHT AND TAGS APPLIED, ALSEK RIVER SOCKEYE SALMON MARK-RECAPTURE PROGRAM, 2004.....8
TABLE 3. TAG RATIOS FROM VARIOUS SAMPLING SITES, ALSEK RIVER SOCKEYE SALMON, 2004.....10
TABLE 4. AGE COMPOSITION FOR THE SOCKEYE CAPTURED IN THE DRY BAY SET GILLNET AND THE SOCKEYE RECOVERED ON THE ALSEK RIVER SPAWNING GROUNDS, 2004.....12
TABLE 5. LENGTH SUMMARY FOR THE SOCKEYE CAPTURED IN THE DRY BAY SET GILLNET AND THE SOCKEYE RECOVERED ON THE ALSEK RIVER SPAWNING GROUNDS, 2004.....13
TABLE 6. SUMMARY OF MIGRATION RATES AND TAGGING PERIOD FOR SOCKEYE RECOVERED FROM THE KLUKSHU RIVER WEIR, 2004.....14

LIST OF FIGURES

FIGURE 1. ALSEK RIVER DRAINAGE AND THE MAJOR TRIBUTARIES.....3
FIGURE 2. DAILY FISHING EFFORT DURING THE ALSEK RIVER SOCKEYE SALMON MARK RECAPTURE PROGRAM, 2004..8
FIGURE 3. SOCKEYE CATCH PER HOUR FISHED DURING THE ALSEK RIVER SOCKEYE MARK RECAPTURE PROGRAM, 2004.....9
FIGURE 4. RUN TIMING THROUGH THE ALSEK RIVER TAGGING SITE FOR KLUKSHU RIVER BOUND SOCKEYE SALMON, 2004.....14

ABSTRACT

Abundance of sockeye salmon (*Oncorhynchus nerka*) returning to spawn in the Alsek River in 2004 was estimated by means of a mark-recapture study conducted by Fisheries and Oceans Canada, the Alaska Department of Fish and Game, and the Champagne and Aishihik First Nation. Age, sex, and length compositions for the sockeye captured at Dry Bay, Alaska and on the spawning grounds were estimated. A total of 1,141 sockeye salmon was captured in set gillnets located 26 kilometres upstream from the mouth of the Alsek River. Of these, 1,103 were tagged. A total of 55 tags was recovered at sites located on or near various spawning grounds (Klukshu River weir, Nesketaheen Lake, and Aboriginal food fishery). Using a modified Petersen estimate model (M =1086, C =3548, R =55), the total in-river run (excluding U.S. commercial catches) was estimated to be 68,917. The Canadian fisheries harvested 2,122 sockeye salmon leaving a spawning escapement of 66,795. The Klukshu River escapement in 2004 was 15,348 which represented 22.3% of the Alsek spawning population. The Nesketaheen Lake estimated escapement of 2,278 accounted for 3.3%. Early run Klukshu sockeye salmon migration peaked during statistical weeks 24 and 25 (weeks ending June 12th and June 19th) through Dry Bay while the late run peaked during week 29 (week ending July 17th).

INTRODUCTION

The Alsek River originates in the Yukon Territory, Canada, and flows in a southerly direction into the Gulf of Alaska, southeast of Yakutat, Alaska (Figure 1). Alsek River sockeye salmon (*Oncorhynchus nerka*) are caught primarily in commercial and subsistence set gillnet fisheries in the lower Alsek River and in aboriginal and recreational fisheries in Canada (Table 1). Small harvests of Alsek sockeye are probably taken in marine commercial gillnet fisheries near Yakutat. These populations are managed jointly by the U.S. and Canada through a subcommittee of the Pacific Salmon Commission (PSC) as part of the U.S./Canada Pacific Salmon Treaty (PST) adopted in 1985 (TTC 1999). The status of sockeye salmon has been evaluated by monitoring escapement trends of what are assumed to be two principal sockeye stocks within the drainage: Klukshu and Nesketaheen Lake sockeye salmon.

Table 1. Alsek River sockeye salmon catch and Klukshu River spawning escapements.

YEAR	ALASKA DRY BAY CATCH	ALASKA Subsistence/ personal use	CANADA SPORT CATCH	KLUKSHU WEIR EARLY	KLUKSHU WEIR LATE	KLUKSHU SPAWN ESC	CANADA ABORIGINAL CATCH
1976	19,741	51	600	181	11,510	7,941	4,000
1977	40,780	113	500	8,931	17,860	15,441	10,000
1978	50,580		500	2,508	24,359	19,017	8,000
1979	41,449	35	750	977	11,334	7,051	7,000
1980	25,522	41	600	1,008	10,742	10,850	800
1981	23,641	50	808	997	19,351	18,448	2,000
1982	27,423	75	755	7,758	25,941	28,899	5,000
1983	18,293	25	732	6,047	14,445	18,017	2,550
1984	14,326		289	2,769	9,958	10,227	2,600
1985	5,940	95	100	539	18,081	17,259	1,361
1986	24,791	241	307	416	24,434	22,936	1,914
1987	11,393	173	383	3,269	7,235	9,346	1,158
1988	6,286	148	322	585	8,756	7,737	1,604
1989	13,513	131	319	3,400	20,142	21,636	1,851
1990	17,013	144	392	1,316	24,679	24,607	2,314
1991	17,542	104	303	1,924	17,053	17,645	2,111
1992	19,298	37	582	11,339	8,428	18,269	2,592
1993	20,043	96	329	5,369	11,371	14,921	2,361
1994	19,639	47	261	3,247	11,791	13,892	1,745
1995	33,112	167	682	2,289	18,407	19,817	1,745
1996	15,182	67	157	1,502	6,818	7,891	1,204
1997	25,879	14	36	6,565	4,738	11,303	484
1998	15,007	121	18	597	12,983	13,580	567
1999	11,441	152	1	371	5,010	5,101	554
2000	9,522	81	0	237	5,314	5,422	745
2001	13,995	72	3	908	9,382	9,329	1,173
2002	16,918	232	61	11,904	13,807	23,587	2,194
2003	39,755	75	61	3,084	31,278	32,120	2,734
2004	18,030	122	247	3,464	11,884	13,721	1,875

In-season management of Alsek sockeye consists of monitoring the commercial fishery at the mouth of the Alsek. Commercial fishery openings and closures are based on the performance

of the commercial fishery expressed in CPUE in year n vs. the average CPUE taken in the past ten years. The aboriginal and sport fishery openings and closures are predicated on the in-season counts of salmon enumerated at the Klukshu River weir and historically, expanded to generate a total run. The escapement goal is thus subtracted from the total run estimate to provide a total allowable catch (TAC).

Since 1976, Klukshu River sockeye, chinook (*O. tshawytscha*), and coho salmon (*O. kisutch*) have been enumerated annually by Fisheries and Oceans Canada (DFO) using a weir located at the Tatshenshini/Klukshu rivers confluence. The weir count of sockeye salmon has been used as the index to reflect the estimated total Alsek River sockeye escapement. Escapements of sockeye salmon migrating to Nesketaheen Lake have been estimated since 1986 using an electronic counter located in Village Creek, approximately, 2 kilometres upstream from its confluence with the Tatshenshini River. No precise escapement goal has been established for Nesketaheen sockeye salmon. Several aerial counts of sockeye salmon have also been obtained on the mainstem Tatshenshini River from Low Fog Creek upstream to Goat Creek. These aerial surveys are not conducted annually due to budget constraints; and therefore, do not serve as an annual index of escapement strength. Below the Canada/U.S. border, aerial surveys are also conducted most years on a few key streams to assess relative sockeye salmon escapement.

The proportion of the total sockeye salmon escapement to the Alsek River drainage counted at the Klukshu River weir had been, historically, unknown. Based on professional judgement, Canada had assumed that the Klukshu River sockeye escapement represented 60% (TTC 1999) of the Alsek River total escapement while the U.S. had assumed it represented 37% (McBride et al 1984). A stock-recruitment analysis of Klukshu River sockeye indicates that the sockeye escapement goal range is 7,500 to 15,000 fish (Clark and Etherton 2000) with a point estimate of 9,400 sockeye. A formal early run escapement goal has not been established due to uncertainties in the behaviour/characteristics of early run sockeye versus late run sockeye. Canada, however, has set an early escapement goal at 1,500 fish, roughly 15 per cent of the total Klukshu escapement goal of 9,400. Although no formal escapement goal has been determined for the entire population of Alsek sockeye, the total run size had been calculated in the following manner. The Klukshu River sockeye salmon count divided by the estimated proportion of Klukshu sockeye (37-60 per cent) that constitutes the total Alsek run, minus the recreational and aboriginal fishery catches yields an escapement estimate for the Alsek River (TTC 1999). The estimated escapement added to the U.S. commercial and subsistence catches yields an estimate of the entire Alsek run.

Prior to the 2000 season, DFO, in co-operation with the Alaska Department of Fish and Game (ADF&G), initiated a program to determine the feasibility of a mark-recapture study to estimate the abundance of Alsek River sockeye salmon. The project was continued for the fifth year in 2004. The objectives of the 2004 study were:

(1) estimate the abundance of sockeye salmon spawning above the U.S. in-river commercial fishery;

(2) determine the age, size, and sex composition of the sockeye salmon spawning above the U.S. in-river commercial fishery;

(3) determine stock specific run timing through the U.S. in-river commercial gillnet fishery for the early and late run Klukshu River sockeye salmon and other Alsek sockeye salmon stocks;

(4) determine contribution levels to the Alsek River sockeye salmon escapement by early and late run Klukshu River sockeye and other Alsek sockeye stocks.

STUDY AREA

The Alsek River drainage covers about 28,000 km^2 (Pahlke et al 2000). The drainage supports spawning populations of anadromous Pacific salmon, including sockeye salmon; however, most anadromous production in the Alsek drainage is limited to the Tatshenshini River because of a velocity barrier on the lower Alsek River near Tweedsmuir Glacier (known as Turnback Canyon)(Figure 1). Significant sockeye salmon spawning has been documented in several tributary systems of the Tatshenshini River, including the Klukshu River system and Nesketaheen Lake (Figure 1). Other significant sockeye salmon spawning areas exist downstream and upstream of the confluence of the Klukshu and Tatshenshini rivers in the Tatshenshini River .

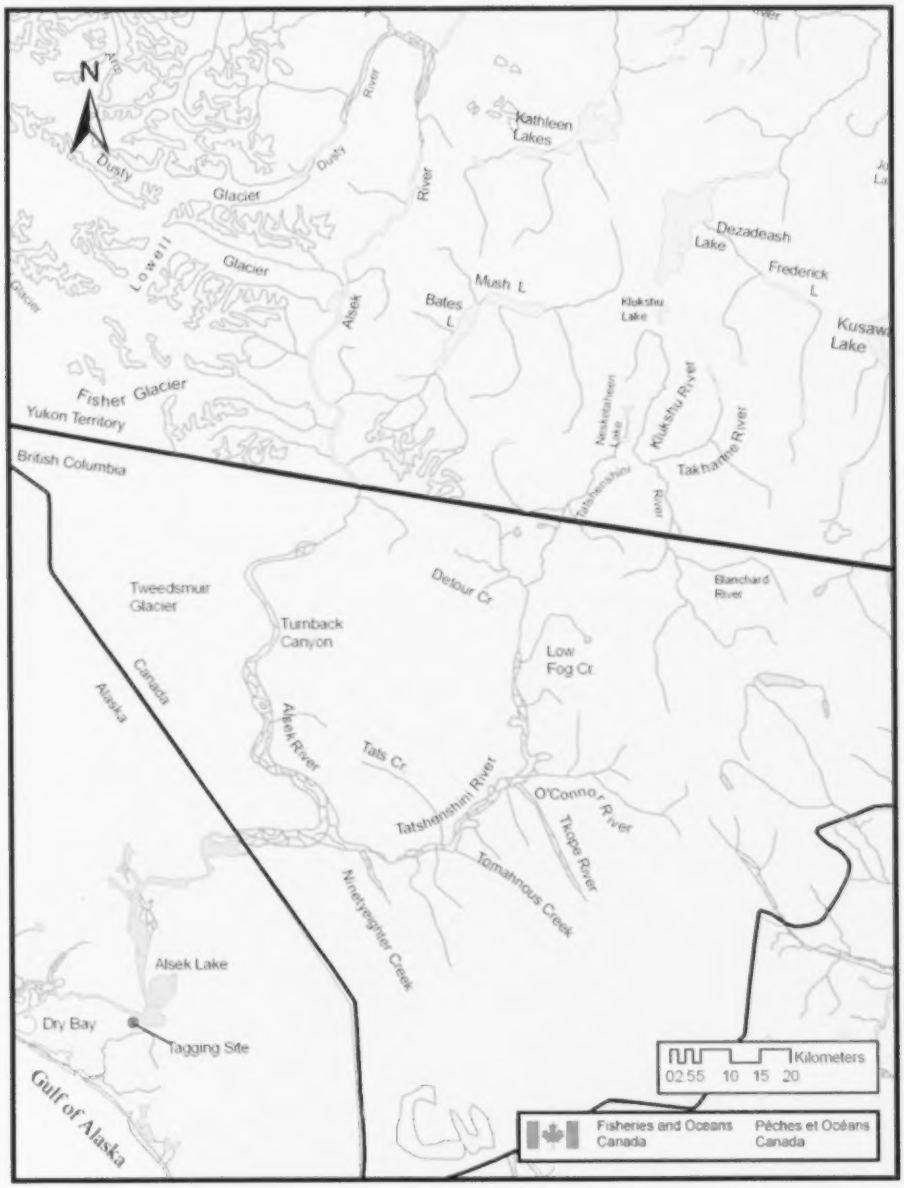

Figure 1. Alsek River drainage and the major tributaries.

METHODS

The number of sockeye salmon in the Alsek River escapement was estimated from a single season two-event mark-recapture study (Ricker 1975). Fish captured by set gillnet in the lower river near Dry Bay and marked were included in event one. Those captured upstream on or near their spawning grounds constituted event two in the mark-recapture study.

DRY BAY TAGGING

In the first event, a set gillnet 30 metres long with 13.4 cm (5 1/4") mesh hung at a 3:1 ratio was fished daily from May 18th to August 18th for approximately 7 hours per day. From May 14th to June 30th, sockeye salmon were also caught incidentally in a set gillnet with 18.4cm (7 1/4") used in a chinook salmon mark-recapture study. Two sites were fished during the duration of the sockeye salmon run. The first was located approximately 17 kilometres upstream of the Alsek River outlet into the Gulf of Alaska and the second was located approximately 500 metres downstream of Alsek Lake (Figure 1). The net was monitored continuously from the adjacent shoreline by a crew of 2 or 3 persons. When a fish was observed in the net, the crew boated out and removed the captured fish. Daily fishing effort was fairly constant for the duration of the study. If fishing time was lost due to equipment problems, it was made up by the end of the day.

Captured sockeye salmon were removed from the net quickly by untangling or cutting the mesh. Fish were then placed in a large, water filled tote, and tagged. Five scales were removed, mid-eye fork length and post-orbital hypural length were taken (to the nearest half centimetre), and the sex was recorded. Sockeye salmon bleeding from the gills were ranked as 1, 2, 3, or 4 with 1 being the least serious and 4 the most. The presence or absence of sea lice *(Lepeophtherius sp.)* was noted (as per Pahlke et al. 2000). General condition of the fish was also recorded e.g. predator scar. Each fish deemed to be in good condition was marked with a uniquely numbered spaghetti tag, consisting of a 6cm (2 ½") section of Floy tubing shrunk onto a 38mm (1.5") piece of 36 kg (80 lbs.) mono-filament fishing line (as per Pahlke et al. 2000). The mono-filament was inserted through the musculature of the fish approximately 2-3 cm. below the posterior end of the dorsal fin with a cannula (hollow) needle and secured by crimping both ends of the tag in a line crimp. Excess monofilament was trimmed off to minimise the chance of snagging the tag while the fish was in transit to the spawning grounds. Each fish was also marked with a 6.3 mm (¼") inch hole applied with a paper punch in the upper portion of the left operculum, and by amputation of the left axillary appendage (as per Pahlke et al. 2000). Sockeye considered being in poor condition were sampled for length, sex, and scales, and released without being marked.

SPAWNING GROUND/FISHERY SAMPLING

In the second event, two known sockeye salmon spawning locations (Klukshu River and Nesketaheen Lake) were sampled to determine the marked/unmarked ratios. Personnel of DFO counted and sampled fish at the Klukshu River weir beginning in June through to the middle of October. Champagne and Aishihik First Nations (CAFN) staff sampled and recorded catch from the aboriginal food fishery upstream and downstream of the Klukshu River weir. The Dalton Post sport fishery, located near the mouth of the Klukhsu River, was also a potential source for tag recoveries. A spawning ground survey was conducted at Nesketaheen Lake from the 2nd to the 3rd of September. All sockeye salmon sampled during the second event of the mark-recapture study were examined for sex, size, and tags/secondary marks, and most had scales or otoliths removed

for ageing. Each sampled fish was marked with a hole punched in the lower left operculum to prevent re-sampling.

ABUNDANCE

The number of marked fish on the spawning grounds was estimated by subtracting the number of marked fish removed in U.S. fisheries from the number of tagged fish in event one. Handling and tagging can cause a downstream movement and/or a delay in continuing upstream migration of marked salmon (Pahlke et al. 2000). This behaviour puts some marked fish at greater risk of capture in the commercial fishery that begins in early June, located immediately downstream from the tagging site. Censoring marked sockeye salmon killed in this fishery limits bias in estimates of abundance.

This censoring also makes estimates relevant to the number of spawning fish, not to the number passing by Dry Bay (Pahlke et al. 2000). The tagging program was publicised and a high proportion of the U. S. catch was inspected for tags. Because of a reward ($5 Canadian per spaghetti tag) for each tag returned from the in-river Canadian recreational and aboriginal fisheries, tags from all marked fish caught in these fisheries were considered recovered.

The application of the mark-recapture experiment requires that several assumptions be met, including (Ricker 1975):

1) All fish have an equal probability to be marked;

2) The marked fish are as vulnerable to recovery as the unmarked fish;

3) The marked fish suffer the same mortality as the unmarked;

4) The marked fish do not lose their mark;

5) The marked fish become randomly mixed with the unmarked;

6) All marks are recognised and reported on recovery;

7) Recruitment and emigration do not occur between sampling events.

The first assumption was addressed by spatial and temporal standards during event one. This assumes that individual stocks migrate at random and do not tend to favour an in-river migration that may avoid or conversely render the fish more likely to be caught in the tagging net. The second assumption was met by ensuring that all sockeye salmon to be marked were handled with care and the handling time was kept to a minimum. Fish deemed to be in poor condition when removed from the net were not tagged. To honour assumption 3, sockeye salmon were tagged with a small orange "spaghetti" type tag designed to reduce the likelihood that the marked fish would be targeted by predators or by sampling crews. Due to the inability to sample sockeye spawners throughout the drainage, not all spawners had an equal probability of recovery, but because the tagging event was random, assumption one was still honoured. The fourth assumption was addressed by marking the tagged fish with a hole punch through the upper left operculum and by severing the left axillary appendage. To ensure that the marked fish were mixed with the unmarked fish, tagging effort was kept constant to ensure all sockeye stocks were targeted. Because of the distance and time to the potential tag recovery sites, it was assumed that the tagged fish would adequately mix with their untagged cohorts (assumption 5). A comparison

of the tagged to untagged ratios for the spawning ground recoveries would indicate if the tagging and recovery effort was random. Assumption 6 was honoured based on the fact that all fish captured on the spawning grounds were examined for tags and secondary marks, and double sampling was prevented by applying an additional hole punched in the lower left operculum. Furthermore, a tag reward of $5.00 CAD ensured that all marked fish were reported. The final assumption was met because the sockeye salmon returning to the Alsek River to spawn were considered to be a closed population. Adjustments were made to the number of marked fish estimated to have made it to the spawning grounds to offset the bias resulting from tagged fish migrating below the tagging site and subsequently, being captured in the U.S. commercial fishery or exiting the Alsek River drainage permanently.

To estimate the abundance of sockeye salmon spawning in the Alsek River, the Adjusted Petersen Estimate was used (Ricker 1975):

$$N = \frac{(M+1)(C+1)}{(R+1)}$$

where: N = estimated abundance of sockeye salmon on the spawning grounds;
M = estimated number of marked sockeye on the spawning grounds;
C = number of adults inspected for marks on the spawning grounds;
R = number of marks found in spawning ground sample.

AGE, SEX, AND LENGTH COMPOSITION OF ESCAPEMENT

All sockeye salmon captured in the set net upstream of Dry Bay were sampled for scales, length, and sex. Five scales were removed from the preferred area of each fish and mounted on gum cards for ageing purposes. Sockeye sampled on the spawning grounds and in the Canadian aboriginal food fishery were sampled for length and sex composition. In cases where time was a concern or that sample sizes for ageing purposes were sufficient, scales were not removed. All scale samples were processed at the DFO ageing lab in Nanaimo, British Columbia. Age and sex composition of the two events were compared to determine if the sockeye caught and tagged at Dry Bay were representative of the sockeye escapement. Estimates of mean length for each age class were determined, as well as, the maximum, minimum, and standard deviation.

MIGRATORY RATES/TIMING

Migration rates were calculated for tagged sockeye salmon recovered at the Klukshu River weir using the following formula:

Migration rate = (distance travelled)/(elapsed time)

Run timing of early and late Klukshu sockeye salmon was plotted on a bar graph depicting the dates of recovered marked fish passing by the tagging site located approximately 4 kilometres upstream of the U.S. commercial fishing boundary.

RESULTS

DRY BAY TAGGING

Between May 14th and August 18th, 2004, 1,141 sockeye salmon were captured in the lower Alsek River. Of these, 1,103 fish were tagged and became the marked component (a 1.5% dropout rate was used in the estimate to account for behavioural effects of tagging) of the mark-recapture study (Table 2). Set gillnet effort was maintained at 7 hours per day, although reduced sampling effort occurred on a few days (Figure 2). No fishing occurred on July 29th due to a flood on the Alsek River. Catch rates ranged from 0 to 3.73 fish/hour and peaked on August 1st, when 28 sockeye were captured (Figure 3). The date of 50% cumulative catch was July 3rd. By August 7th, 90% of the sockeye had been caught. The sex composition of sockeye salmon caught in the $5^{1/4"}$ set net was skewed slightly towards males (465 females & 498 males). Combine both the $5^{1/4"}$ and $7^{1/4"}$ nets; the bias towards males is very apparent (518 females & 625 males) which suggests that females are less likely to be caught in the larger mesh size.

Table 2. Summary of sockeye caught and tags applied, Alsek River sockeye salmon mark-recapture program, 2004.

Stat Week	Week End (Sat)	Net Size	Effort Fished (Hours)	# caught	# tagged
21	22-May	51/4" & 71/4"	74.6	18	18
22	29-May	51/4" & 71/4"	105.5	76	71
23	5-Jun	51/4" & 71/4"	105.4	124	123
24	12-Jun	51/4" & 71/4"	105.7	81	76
25	19-Jun	51/4" & 71/4"	105.9	129	123
26	26-Jun	51/4" & 71/4"	104.3	73	70
27	3-Jul	51/4" & 71/4"	97.1	88	87
28	10-Jul	51/4"	49.3	87	82
29	17-Jul	51/4"	49.4	91	89
30	24-Jul	51/4"	45.6	77	73
31	31-Jul	51/4"	43.8	79	76
32	7-Aug	51/4"	50.7	136	136
33	14-Aug	51/4"	49.3	68	65
34	21-Aug	51/4"	37.0	14	14
	Total			1141	1103

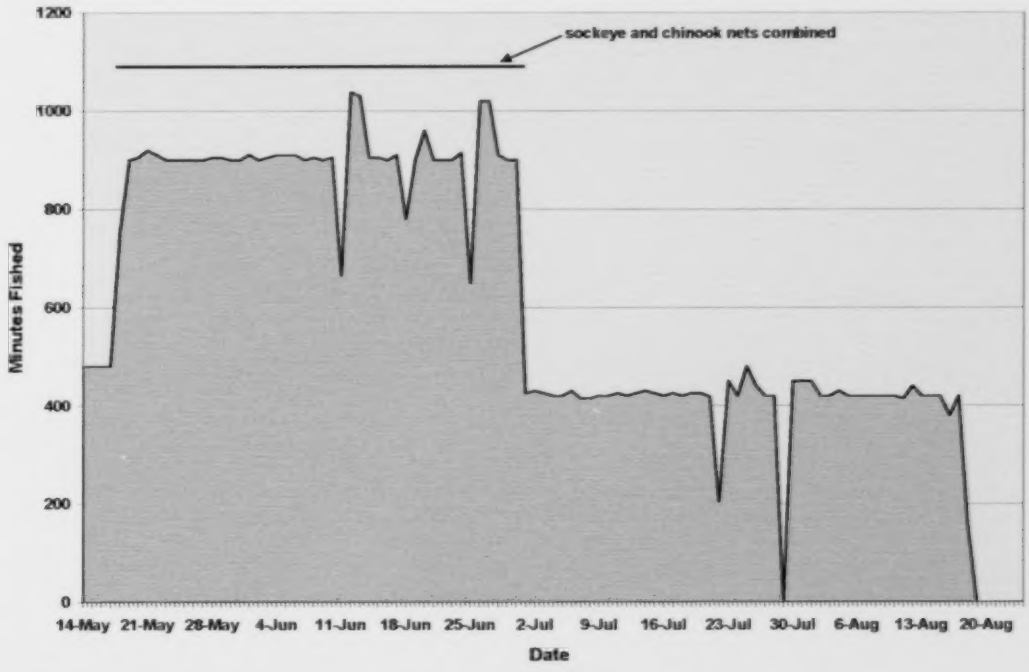

Figure 2. Daily fishing effort during the Alsek River sockeye salmon mark recapture program, 2004.

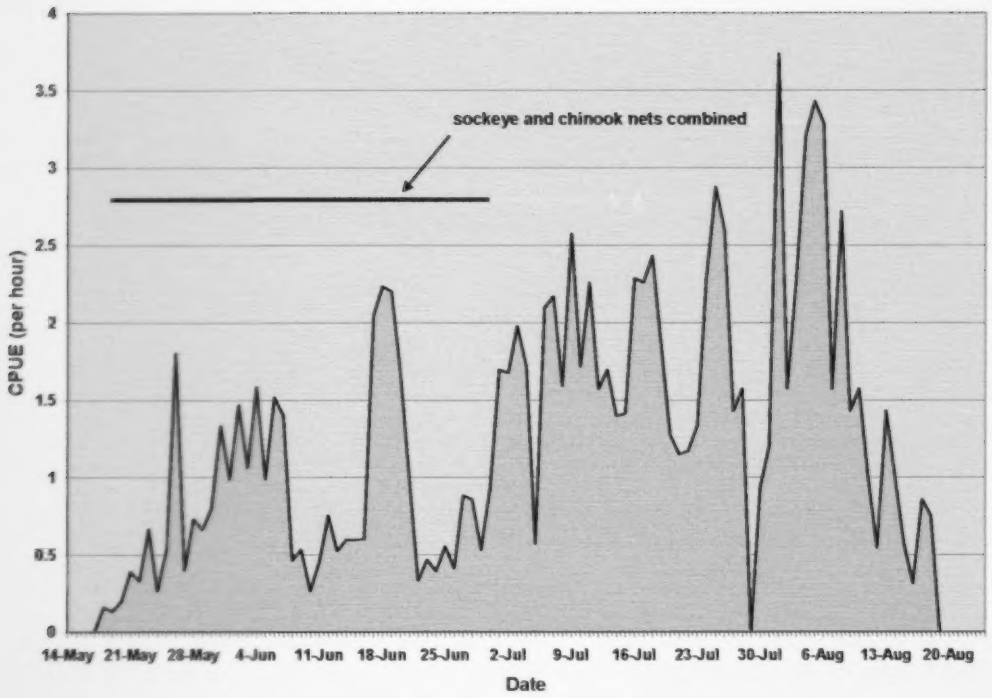

Figure 3. Sockeye catch per hour fished during the Alsek River sockeye mark recapture program, 2004.

SPAWNING GROUND/FISHERY SAMPLING

A total of 2,515 sockeye salmon was examined for marks at the Klukshu River weir (2,512 live and 3 carcasses), and 47 marked fish were recovered (Table 3). No incidence of tag loss was noted in the sample of fish examined. The remaining 12,561 fish passing through the weir were not physically examined for marks; however, each fish was observed while in transit and the presence of 77 additional spaghetti tags was noted. Sex of each fish was not estimated. The Klukshu River aboriginal food fishery harvested a total of 1,875 sockeye salmon of which 24 fish had spaghetti tags. Three were recovered in the food fishery sample (n=580). The Dalton Post sport fishery provided little opportunity for samples as the catch was limited even though sockeye salmon abundance was above average for the Klukshu River system.

Table 3. Tag ratios from various sampling sites, Alsek River sockeye salmon, 2004.

SITE	OBSERVED # MARKS	# EXAMINED	TAG TO UNTAGGED RATIO
Klukshu Weir Observations	77	12561	163
Klukshu Weir Live Samples	47	2512	53
Aboriginal Sample	3	580	193
Aboriginal Catch (including sampled)	24	1875	78
Nesketaheen Lake	5	456	91
Mainstem Tatshenshini	Not conducted in 2004		
Total Klukshu Weir Handled	47	2512	53
Klukshu Handled, Nesk., & AFF sample	55	3548	65
Total Handled & Catch	76	4843	64

At Nesketaheen Lake, a total of 456 sockeye salmon was examined for marks and 4 tagged fish were recovered. One tag was reported missing for a total of 5 marks observed. No spawning ground surveys were conducted in the Tatshenshini River in 2004.

ABUNDANCE

Tagged to untagged ratios observed at the primary recovery locations (Klukshu River weir samples and spawning ground sampling at Nesketaheen Lake) are presented in Table 3. The Klukshu River live sample had a tagged to untagged ratio of 1:53. Nesketaheen Lake had an observed tagged to untagged ratio of 1:91. The sockeye salmon observed in transit through the Klukshu River weir had a tagged to untagged ratio of 1:163. The aboriginal food fish catch had a tagged ratio of 1:78.

An in-river run size estimate above the US fishery using the recoveries from the Klukshu River weir samples, the aboriginal food fishery and Nesketaheen Lake and a 1.5% dropout rate at Dry Bay was 68,917 sockeye salmon. Adding the total catch of 18,152 Alsek sockeye taken in the Dry Bay commercial fishery and the Dry Bay subsistence fishery accounts; therefore, for a total run of 87,069 sockeye. The total in-river spawning escapement was 66,795 (68,917 – 2,122 aboriginal/sport catches) (Appendix 1) (note: US origin sockeye are caught in unknown quantities in the Dry Bay net fisheries, but these catches were not partitioned out of the estimate. It is assumed that the catches of Canadian origin sockeye salmon taken in nearby ocean fisheries offset the number of US origin fish taken at Dry Bay.) Tagged fish in transit through the Klukshu River weir were not used to generate this estimate because of the uncertainty regarding assumption #6: that all marked fish are reported. This assumption was in all likelihood violated due to the colour of the tag, poor lighting conditions at night, and the turbid water conditions that are frequently observed at the Klukshu River weir. All marked fish that migrated downstream and were caught in the Dry

Bay fishery or elsewhere were censored from this estimate and in addition, another 1.5% was taken off the total marked component to compensate for undetected downstream loss or tag induced mortality.

AGE, SEX, AND LENGTH COMPOSITION OF ESCAPEMENT

The primary age component of sockeye salmon for all spawning ground recoveries was 5(2) (Table 4). The Dry Bay tagging sample was comprised of 79% 5(2), the aboriginal food harvest contained 94%, the Klukshu River weir live sample 98%, and the Nesketaheen Lake 96%. The 4(2) age class was the next prominent for all samples. The Dry Bay tagging sample contained 17% age 4(2), aboriginal food harvest 5%, the Klukshu weir sample 2%, and the Nesketaheen sample 4%. A chi square test (Appendix 2) was applied to the age composition obtained during the tagging event versus those recovered on the spawning grounds (Klukshu and Nesketaheen). The age composition for the Nesketaheen Lake sample ($x^2 = 16.53$, df = 5, P = 0.035) was found to be statistically different than the age composition at Dry Bay as was the Klukshu River age composition ($x^2 = 3110.92$, df = 5, P = 0.000).

A summary of mean post-orbital hypural lengths is found in Table 5. A chi square test (Appendix 3) was applied to the samples obtained during the tagging event versus those recovered on the spawning grounds (Klukshu and Nesketaheen). It was found that the hypural lengths recorded at the Klukshu River weir ($x^2 = 65.97$, df = 4, P = 0.000), and at Nesketaheen Lake ($x^2 = 2635.25$, df = 4, P = 0.000) were significantly different than those lengths taken at Dry Bay.

Table 4. Age composition for the sockeye captured in the Dry Bay set gillnet and the sockeye recovered on the Alsek River spawning grounds, 2004.

		Age Class					
		3(2)	4(2)	5(2)	5(3)	6(2)	6(3)
Dry Bay Tagging							
Male	N	1	66	224	5	1	6
	Percent	0.18%	11.79%	40.00%	0.89%	0.18%	1.07%
Female	N		26	221	1		9
	Percent	0.00%	4.64%	39.46%	0.18%	0.00%	1.61%
Klukshu Weir							
Male	N	0	117	8900	0	19	80
	Percent	0.00%	0.76%	57.99%	0.00%	0.12%	0.52%
Female	N	0	123	6109	0		0
	Percent	0.00%	0.80%	39.80%	0.00%	0.00%	0.00%
Aboriginal Food Fishery							
Male	N	0	5	79	0	1	0
	Percent	0.00%	3.82%	60.31%	0.00%	0.76%	0.00%
Female	N	0	2	44	0		0
	Percent	0.00%	1.53%	33.59%	0.00%	0.00%	0.00%
Nesketaheen Lake							
Male	N	0	3	42	0	0	0
	Percent	0.00%	3.03%	42.42%	0.00%	0.00%	0.00%
Female	N	0	1	53	0	0	0
	Percent	0.00%	1.01%	53.54%	0.00%	0.00%	0.00%

Table 5. Length summary for the sockeye captured in the Dry Bay set gillnet and the sockeye recovered on the Alsek River spawning grounds, 2004.

		Age Class					
		3(2)	4(2)	5(2)	5(3)	6(2)	6(3)
Dry Bay Tagging							
Male	N	1.0	66.0	224.0	5.0	1.0	6.0
	Avg. POHL	275.0	454.2	512.3	427.0	535.0	508.3
	Std. Dev.		48.0	25.4	34.4		20.4
Female	N		26.0	221.0	1.0		9.0
	Avg. POHL		459.6	495.1	470.0		491.1
	Std. Dev.		27.3	21.6			20.1
Klukshu Weir							
Male	N		10.0	310.0		1.0	4.0
	Avg. POHL		502.0	500.1		519.5	469.8
	Std. Dev.		18.3	27.7			42.4
Female	N		6.0	242.0			
	Avg. POHL		447.8	484.1			
	Std. Dev.		44.4	25.1			
Aboriginal Food Fishery							
Male	N		5.0	79.0		1.0	
	Avg. POHL		493.0	509.3		505.0	
	Std. Dev.		20.1	23.5			
Female	N		2.0	44.0			
	Avg. POHL		475.5	487.3			
	Std. Dev.		7.8	19.3			
Nesketaheen Lake							
Male	N		3.0	42.0			
	Avg. POHL		415.0	483.9			
	Std. Dev.		70.0	16.5			
Female	N		1.0	53.0			
	Avg. POHL		415.0	462.7			
	Std. Dev.			12.9			

MIGRATORY RATES/TIMING

Marked sockeye salmon bound for the Klukshu River took an average of 52.1 days to migrate from the tagging site to the Klukshu River weir site (Table 6). Maximum number of days in transit was 86 and the minimum was 33. On average, the tagged Klukshu River sockeye migrated 3.6 kilometres per day. The total days in transit for Nesketaheen sockeye is not known because sampled fish were collected from the spawning grounds and would have matured in the lake for an unknown period.

Table 6. Summary of migration rates and tagging period for sockeye recovered from the Klukshu River weir, 2004.

	# RECOVERED	DAYS IN TRANSIT	MIGRATION RATE KM/DAY	TAGGING PERIOD FIRST FISH	LAST FISH	MAX.	MIN.
Klukshu River	47	52.1	3.60	26-May	9-Aug	86	33

Figure 4 illustrates the run timing through the Dry Bay tagging site for Klukshu River bound sockeye salmon. Klukshu sockeye appeared to exhibit two distinct peaks. The first peak occurred during week 24/25 (week ending 12th of June and 19th of June) and then week 29 (week ending 17th of July).

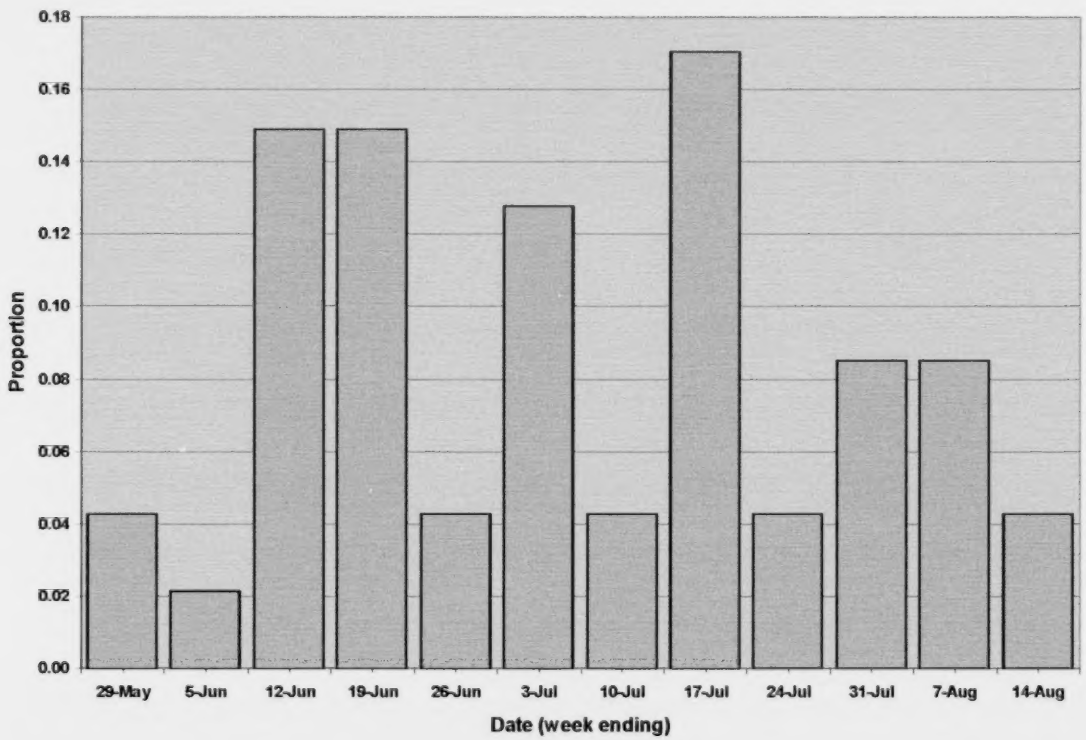

Figure 4. Run timing through the Alsek River tagging site for Klukshu River bound sockeye salmon, 2004.

DISCUSSION

In 2004, Klukshu River sockeye salmon stocks comprised 22.3% (15,348 weir count) of the total above U.S. fishery escapement estimate of 68,917. This Klukshu contribution estimate is approximately 37.7% below the historical Canadian fisheries managers' estimate of 60%, and 14.7% below the 37% contribution rate that had been estimated by ADF&G managers. Nesketaheen Lake sockeye salmon represented 3.3% (2,278 fish) of the total Alsek River escapement. Alsek River sockeye run reconstruction for 2000 – 2003 and the Klukshu contribution for the same period are found in Appendix 4.

The tagging estimate generated from the mark-recapture experiment is probably within an acceptable level of reality. If the tagging estimate was inflated due to violations of the assumptions of the study; specifically, that all tagged fish have an equal probability of recapture (no mortality or tag loss), one would expect that the harvest rate from the Dry Bay fishery would have been lower than 21 per cent (18,152/87,069). A 21 per cent harvest rate appears to be a reasonable estimate based on the below average number of days open (average opening: 2.0 days with 8 fishers) for the commercial fleet.

As in 2000 through to 2003, the discrepancy between past estimates and the estimate of the 2004 Klukshu sockeye contribution to the total Alsek sockeye production when compared to past estimates is likely attributed to the inaccuracy of the historic assumptions and assessments. In 2004, the Klukshu escapement was about average but still represented less (22.3%) of the total Alsek sockeye production than was previously thought. The Klukshu component (based on an unpublished study which looked at sockeye distribution in the Alsek drainage) likely represents the largest single discreet sockeye stock within the Alsek River watershed but even in years of good abundance, still does not contribute what had previously been assumed.

In-order to quantify the number of marked sockeye salmon that were removed from the study and unavailable for recovery on the spawning grounds, a 1.5% dropout rate (based on the results found in the 2001 to 2003 Alsek sockeye radio telemetry program) in addition to the tagged fish that were re-captured in the U.S. fisheries was used. Tag induced stress can often lead to disorientation which can make them more vulnerable to predators, in this case, seals. In-river mortality of sockeye salmon by seals no doubt occurs in fish that are unmarked, but it is felt that the likelihood is greater for sockeye that have been through the capture and marking event. The distance upstream (26 km) from the Alsek River terminus would decrease the likelihood that sockeye from other systems would be available for capture during the marking event. Some mortality due to net induced injury was also assumed to have occurred in sockeye that were captured during the marking event.

Observations of sockeye salmon in transit through the Klukshu River weir increased the total number of fish examined for marks but the reliability of this sample may have been poor. The orange spaghetti tag used in the study was designed to prevent predators from targeting marked fish but this also may have made it more difficult for the weir crew to recognise a tagged fish. Efforts by the weir crew on the Klukshu River in 2004 resulted in a good sample size; therefore, improving the accuracy of the estimate. As in the past, sampling the aboriginal food fish catch was relatively successful considering the large area that the food fishery encompasses and the limited resources available to monitor the fishery. Spawning ground sampling at Nesketaheen Lake provided additional recovery information. Conducting the survey in early September reduced the disruption to the spawners and reduced the number of pre-spawned sockeye handled but also provided reasonable numbers of sockeye available for sampling.

The size composition difference between the tagging event and the spawning ground samples (Klukshu and Nesketaheen) is difficult to explain. One possibility is that the sockeye stocks sampled are smaller on the whole than other stocks within the Alsek drainage. Another possibility is that as sockeye migrate closer to their natal areas, sexual dimorphism becomes more pronounced which may alter the skeletal structure enough to change any length measurement taken from ocean entry to the spawning grounds. Also, the mesh size used in the experiment may have reduced the likelihood that smaller sockeye would be captured; therefore, biasing the sockeye sample towards larger fish.

RECOMMENDATIONS

Estimating the sockeye salmon escapement to the Alsek River drainage appears to be feasible. Set nets are an effective method for capturing sockeye salmon in transit to the spawning grounds even though fluctuating river levels may influence the gear efficiency. The following are recommended to ensure the precision of the abundance estimate and the development of a sound abundance based management regime:

(1) Continue the program to further develop and refine the abundance based management regime currently being investigated (weekly commercial CPUE in the Dry Bay fishery has been found to have a significant relationship with the post season mark-recapture estimate);

(2) Continue the tagging program, beginning in mid-May, to ensure that early run sockeye salmon stocks like Nesketaheen/Blanchard are marked at the same rate as the later sockeye salmon stocks;

(3) Ensure a crew of three technicians (2 DFO and 1 ADF&G) are stationed at Dry Bay to tag sockeye salmon;

(4) Continue efforts to increase the sample size at the Klukshu River weir to better represent the tagged to untagged ratios for Klukshu River bound sockeye salmon. Identify mainstem Alsek/Tatshenshini rivers spawning sites to increase the sample size for non-Klukshu stocks. Investigate the Blanchard River system to determine if sockeye can be recovered in sufficient numbers to assess the tagged to untagged ratio.

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APPENDICES

Appendix 1. Alsek River sockeye population estimate, 2004 (Klukshu weir/below, Nesk., & AFF samp. - Handled Fish Only)

tags recovered=	55 =R
total examinations associated with tags=	3548 =C
total tags applied=	1103
censored (commercial U.S. catch)=	0
total adjusted tags applied= 1.5% Drop-out Rate	1086.46 =M

adjusted Petersen Estimate= $\frac{(M+1)(C+1)}{(R+1)}$

		Total	Comm./Sub. Catch	Total Run
adjusted Petersen Estimate=	point est	68917	18152	87069
	max	89229	18152	107381
	min	53169	18152	71321

	weir #	% of total
Percent to Klukshu	15348	22.3%
Percent to Nesketaheen	2278	3.3%

Harvest Rate @ Dry Bay 20.8%

CI 95%	tags	tags+1.92	1.96*sqrt(R+1)	equals		95% CI RANGE	
	55	56.92	14.667		42.3	Upper R	89229
	55	56.92	14.667		71.6	Lower R	53169

Appendix 2.
Chi-square test of the age composition observed for Dry Bay sockeye versus what was observed at the Klukshu River weir and at Nesketaheen Lake, 2004.

	Sampling Event (Observed)						
Site	3(2)	4(2)	5(2)	5(3)	6(2)	6(3)	Total
Dry Bay	1	92	445	6	1	15	560
Klukshu	0	268	14981	0	19	80	15348
Nesketaheen	0	4	95	0	0	0	99

	Expected						
Site	3(2)	4(2)	5(2)	5(3)	6(2)	6(3)	Total
Dry Bay	NOT APPLICABLE						
Klukshu	27	2521	12196	164	27	411	15348
Nesketaheen	0	16	79	1	0	3	99

	Calculations								
Site	3(2)	4(2)	5(2)	5(3)	6(2)	6(3)	x^2	DF	P
Dry Bay	NOT APPLICABLE								
Klukshu	27	2014	636	164	3	267	3110.92	5	0.000
Nesketaheen	0	9	3	1	0	3	16.53	5	0.035

$X^2 = 11.07$ @ 0.05

There is a significant difference in age composition between the tagging event and the Nesketaheen and the Klukshu River weir.

Appendix 3.
(POH) frequency observed for Dry Bay sockeye versus what was observed
e Klukshu River weir and Nesketaheen Lake 2004.

	Sampling Event (Observed)					
Site	< 401 mm	401 - 450 mm	451 - 500 mm	501 - 550 mm	> 550 mm	Total
Dry Bay	23	90	505	489	36	1143
Klukshu	47	172	1229	1046	17	2511
Nesketaheen	28	326	96	6	0	456

	Expected					
Site	< 401 mm	401 - 450 mm	451 - 500 mm	501 - 550 mm	> 550 mm	Total
Dry Bay	OT APPLICABLE					
Klukshu	51	198	1109	1074	79	2511
Nesketaheen	9	36	201	195	14	456

	Calculations							
Site	< 401 mm	401 - 450 mm	451 - 500 mm	501 - 550 mm	> 550 mm	x^2	DF	P
Dry Bay	OT APPLICABLE							
Klukshu	0	3	13	1	49	65.97	4	0.000
Nesketaheen	39	2344	55	183	14	2635.25	4	0.000

$X^2 = 9.49$ @ 0.05
Therefore, there is a significant difference in length frequency between the tagging sample and the Klukshu weir, Nesketaheen Lake, and Tatshenshini River samples.

Appendix 4. Alsek River sockeye escapement, 2000-2003. Estimates are based on a mark-recapture study.

Year	Inriver Run Estimate	Confidence Interval Lower	Upper	Canadian Catch	Spawning Escapement	U.S. Catch	Total Run	Percent Klukshu
2000	39413	28393	56256	745	38668	9668	49081	14%
2001	37917	30878	45539	1177	36740	14067	51984	27%
2002	79546	63249	99972	2255	77291	17150	96696	32%
2003	90088	74927	108287	2795	87293	39874	129962	38%
Averages 00-03	61741			1743	59998	20190	81931	28%